Mapping the Expansion History of the Universe

Timothy McKay, for the SNAP collaboration

Physics Discoveries

Launch

Assembly

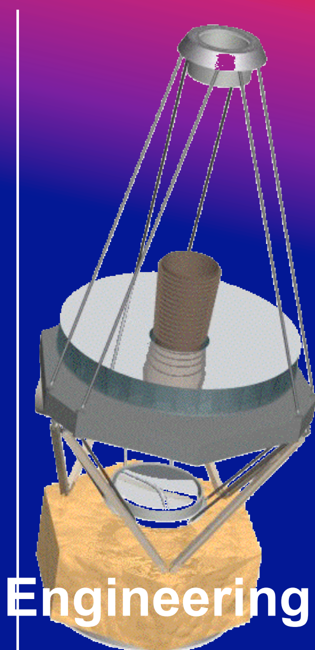
Configuration

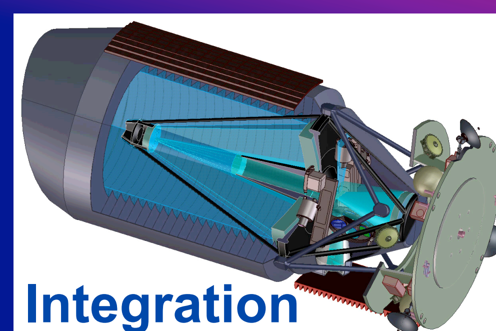
Development

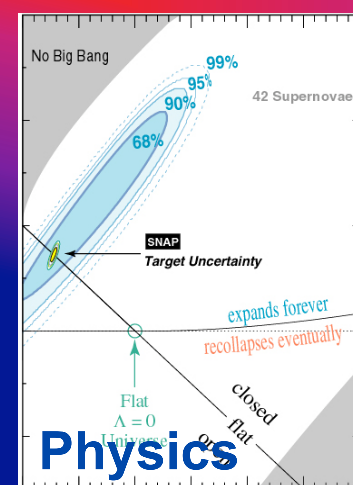
2002

SNAP: The Supernova/Acceleration Probe

2010

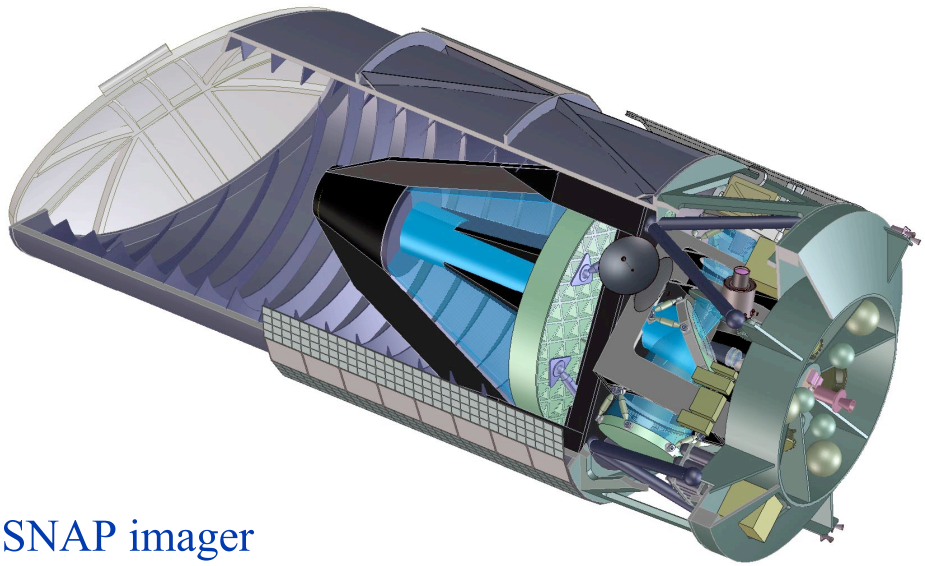






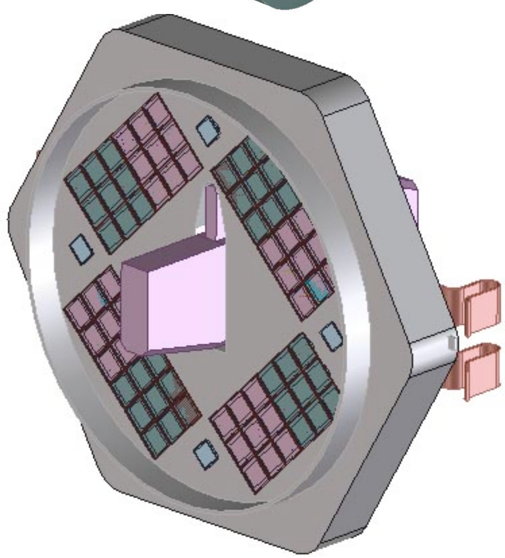
SNAP Overview (see snap.lbl.gov for details)

SuperNova /Acceleration Probe: the first optical/near-IR survey telescope in space



SNAP imager

AN ARRAY OF OPTICAL AND NIR DETECTORS WILL BE ASSEMBLED INTO AN ANNULUS NEARLY ONE HALF METER WIDE, THE LARGEST AND MOST SENSITIVE ASTRONOMICAL IMAGER EVER CONSTRUCTED



SNAP Basics:

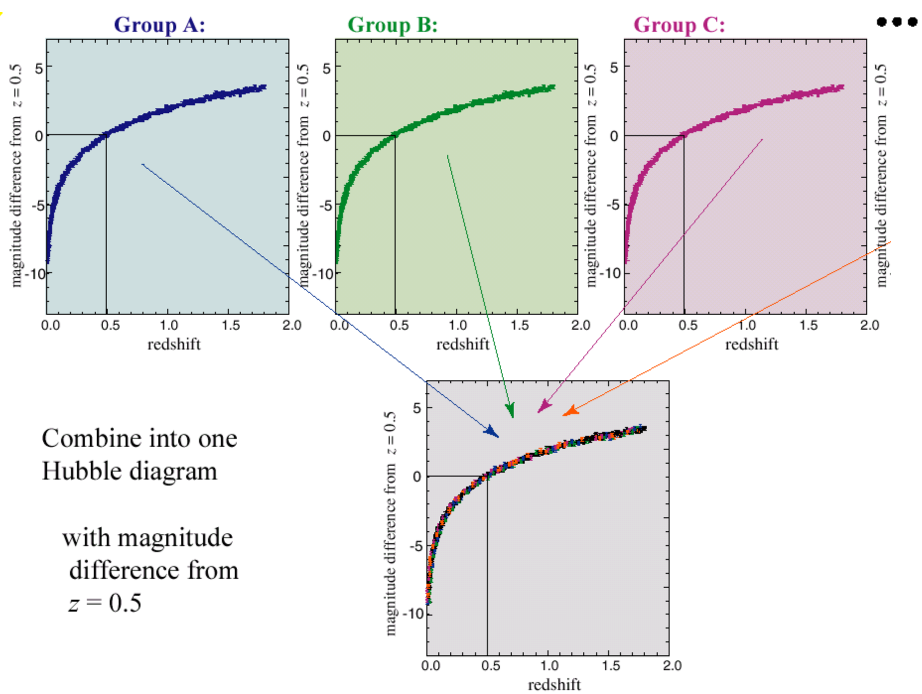
- **2m space telescope in high Earth orbit → precise measurements of very faint distant supernovae**
- **1 square degree optical/NIR imager with ~1 billion pixels → simultaneous measurements of many supernovae from z=0.2 – 1.6**
- **0.35-1.7μm spectrograph → detailed analysis of each supernova**

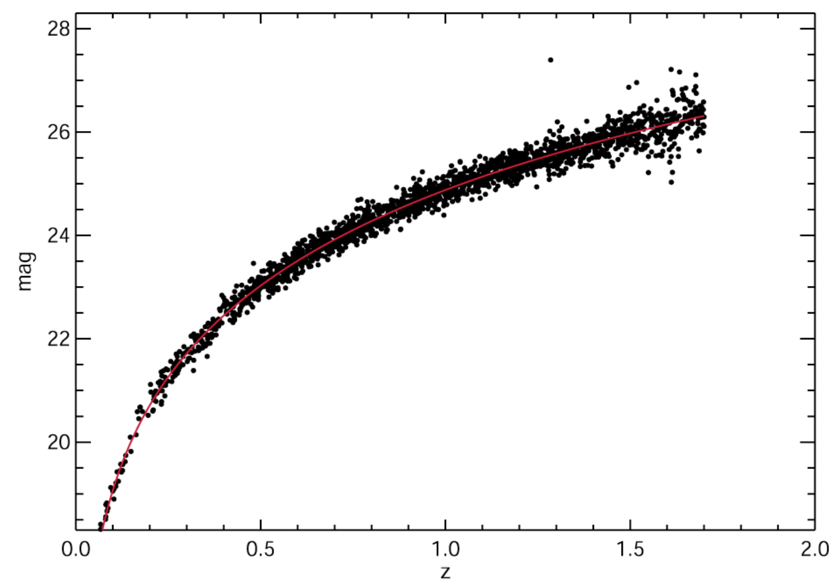
SNAP Science Goals:

- **~2000 SNe a year in 15□°, each with better data than are now obtained for the best ground based observations**
- **Exhaustive control of systematic errors including dust, evolution, and lensing**
- **An m_{AB}=29.5 survey 4000x larger than the HST ACS survey in 9 passbands**
- **A 300□° weak lensing survey to m_{AB}=27.5 → provides complementary cosmological constraints**

Supernova Cosmology with SNAP

- **Type Ia supernovae are 'standardizable' candles: their Hubble diagrams reveal the expansion history of the universe □ dark energy**
- **Obtaining precise and accurate Hubble diagrams requires careful control of systematic errors**
- **Steps to a final Hubble diagram**
  1. **Group observed supernovae into extinction corrected Hubble diagrams for subsets based on: host type, metallicity, rise time, velocity of spectral features, stretch**
  2. **Combine Hubble diagrams fitting for simple luminosity offsets**
  3. **Study distribution vs. z to constrain lensing magnification**
- **Constraints on dark energy: equation of state w and it's time variation w□**

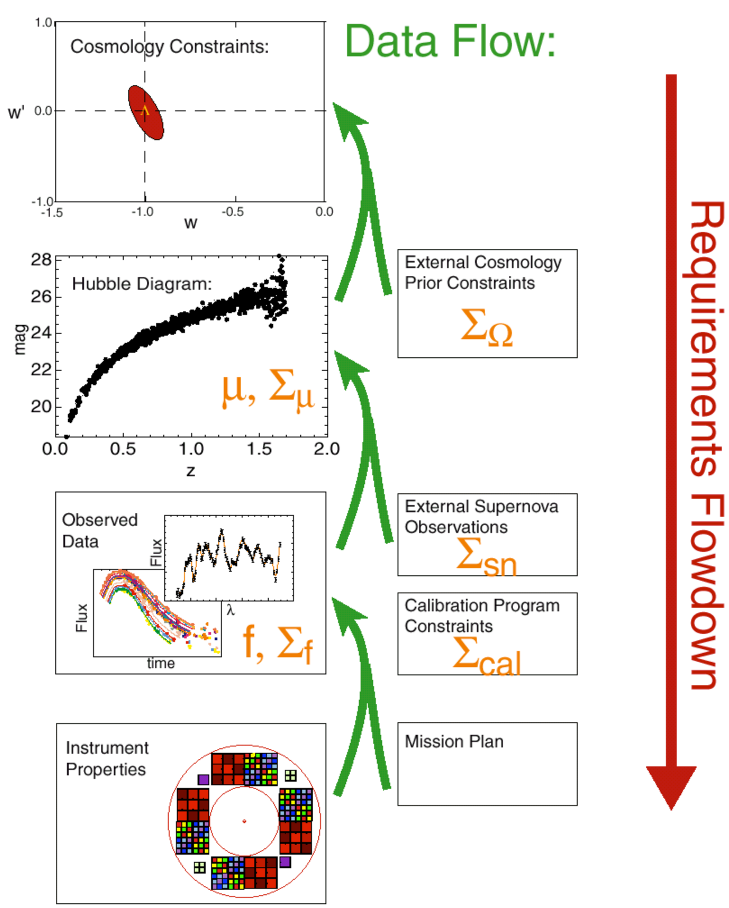


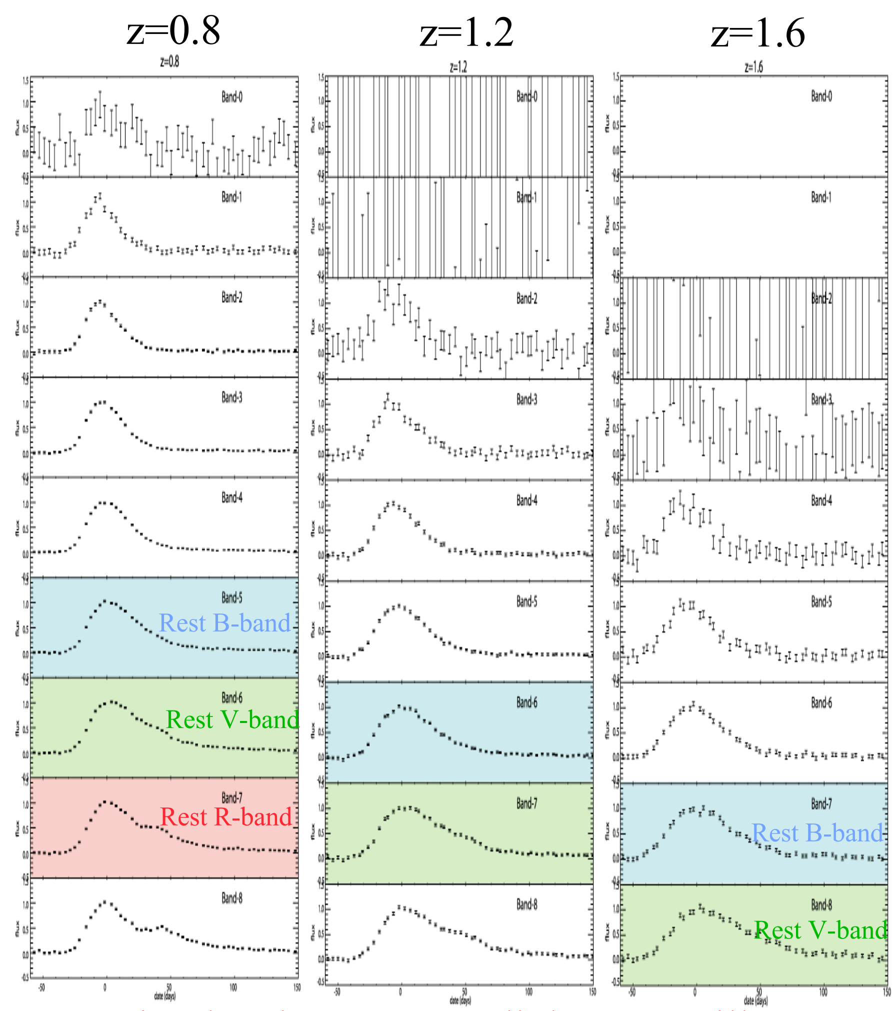


Predicted final SNAP Hubble diagram including statistical and systematic errors

Simulated SNAP Light Curves

SNAPfast simulations propagate errors down from the instrument to cosmological constraints, and propagate requirements from the desired cosmology constraints to the instrument design



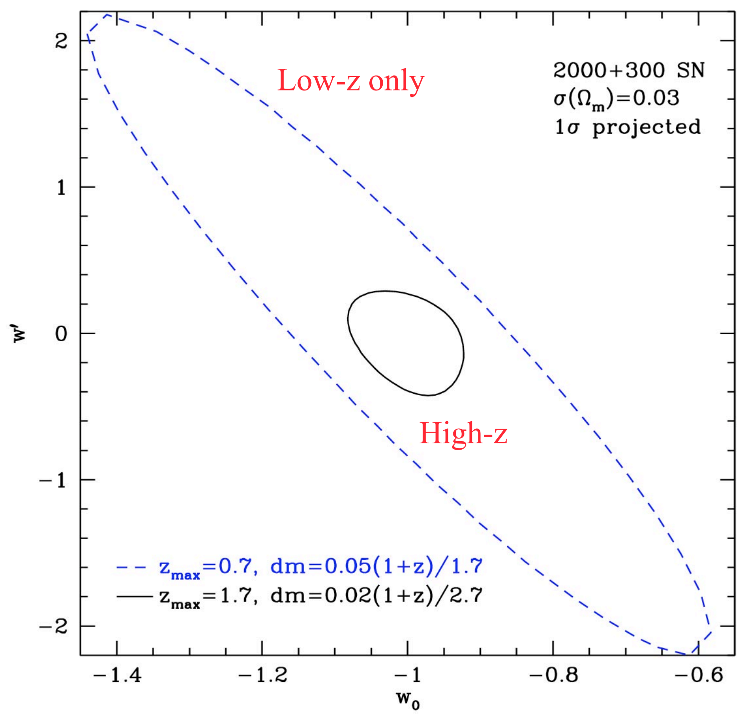


Simulated SNAP SNe light curves illustrate high quality data to the highest redshifts

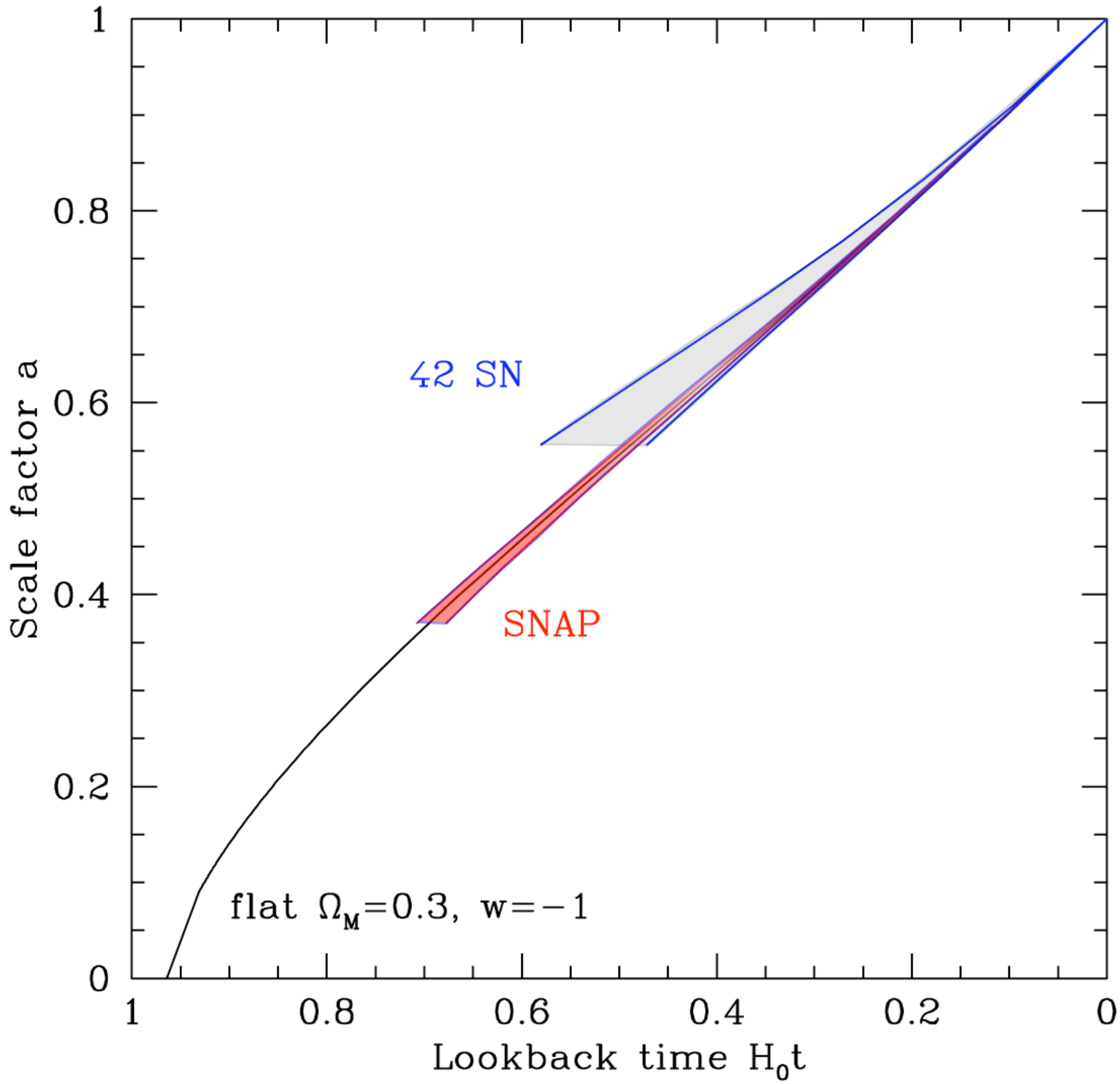
From Data to Cosmology

- Experiment provides Hubble diagram(s) of observed SN together with error matrix: $\mu(z)$, $\sigma_{\mu\mu'}$
- Simulations incorporate statistical and systematic uncertainties
- Monte Carlo cosmology fitter outputs cosmology parameters and likelihood surface
- Confidence level contours in N space: $\{\Omega_M, \Omega_\Lambda, w_0, w', M\}$ generally 2 at a time.
- To see *what* (not *that*) dark energy is, to probe w', requires z_{max}>1.5
- Priors from complementary probes will be important but they can't get at time variation w'

SN surveys in space represent a major advance in understanding dark energy



Expansion history of the Universe



SNAP will provide a precise measurement of the expansion history of the universe, stretching back over more than half its lifetime.

This is a key element in establishing a precise, accurate, quantitative cosmology for the 21st century.

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